“A Good Balance of Costs and Benefits” – Convincing a University Administration to Support the Installation of an Interactive Multi-Application Display System on Campus

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ABSTRACT
Interactive digital signage systems allow passers-by to take (temporary) control of a public display in order to select content and applications of interest, or even upload content of their own. Not surprisingly, display owners are hesitant to embrace such interactivity, given the uncertainty of what will be shown on their displays. In this paper we summarize our experience of deploying an interactive multi-application display system in the context of a university environment, and in particular our engagements with display owners (i.e., university administration) in order to convince them and get their support for the installation and deployment of such a system. We present the results of semi-structured interviews with display owners regarding their motivations, needs, and concerns with respect to the deployment of such a system at our university. While one cannot generalize from our results, we nevertheless believe that our experiences offer helpful advice to developers of such systems (and/or researchers interested in designing and studying them) in order to aid them in successfully gathering the support of these important stakeholders.

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INTRODUCTION
Most of today’s public displays are still designed around the traditional digital signage model, which provides control only to what we call “display owners” – individuals or organizations that physically own or operate public displays [1]. Recent work in public display research has proposed a number of multi-application interactive systems to better engage with different stakeholders, such as e-Campus [2], InstantPalces [10], and UBI-hotspots [14]. These systems allow passers-by to not only influence content display, but in some cases to also upload and show their own content. Opening public displays up to viewers with the help of interactive applications can make public displays more attractive and more appreciated in their environment [3].

Figure 1. Deployed Interactive Display at the University

Maybe not surprisingly, convincing display owners to change an existing display to move from a traditional signage model to an interactive signage model, or to newly install an interactive display, is a non-trivial task. Note that a display owner might not actually *own* the display. Instead, they own (or operate) the space where the display is located in, and hence need to explicitly sanction the installation and operation of the display. Hosio et al. [9] have thus called this type of stakeholder “location managers” instead. In their study they conclude that the value of a display installation to location managers (our “display owners”) can be fundamental to the sucess of a long-term display deployment. As we experienced in our own work, much of the efforts in creating a long-term in-the-wild deployment were spent in getting display owners “on-board”, not only allowing us to set up such displays on some remote part of the campus, but to openly embrace this concept and place such displays in key locations on campus.

In this paper we summarize our experience of deploying interactive multi-application display system in the context of a university and engaging display owners during the deployment. We build upon our previous work on identifying and understanding the scheduling requirements of display owners [5] and content needs of the student community [13], identifying key scheduling challenges [4], providing a display control interface for display owners [7], developing a novel web based scheduling platform for public displays with a set of interactive and concurrently running applications [6],

and deploying a network of four interactive multi-application screens at the University of Lugano (USI) as shown in Figure 1 [11]. The remainder of this paper is organized as follows: First, we present a high-level description of the deployed system and its use at the university over a period of (by now) 96 weeks. Second, we present the results of several semi-structured interviews with university administration. We report on their needs, concerns, and experience of deploying such a system at the university. We believe that our work offers meaningful suggestions and valuable insights to developers of such display systems on how to engage with display owners, to ultimately open up public displays to interactive applications and end-user-supplied content.

RELATED WORK

A number of projects have previously suggested the use of both interactivity and user-contributed content in order to increase viewer participation. However, only a small number of projects have been concentrating on developing multi-application systems that satisfy the presentation requirements of multiple stakeholders, such as e-Campus [2], Instant Places [10], and UBI-hotspots [14]. We complement this existing work on interactive multi-application display systems by uncovering additional motivations, needs, concerns, and experiences of display owners for giving up control of displays. Below we briefly discuss the three above-mentioned systems.

Instant Places is a display platform that features a number of web-based display applications such as a "presence" application that shows the profiles of users around the displays and their interests in the form of small "pins", or a bigger "poster" application for publishing user contributed content [10]. The platform shows these applications in a predefined time intervals controlled by the display owners. While display viewers can personalize individual applications by contributing their own content, they cannot take control over the displays and application presentation.

UBI-hotspots is a network of touch-enabled indoor and outdoor public displays installed in the city center of Oulu, Finland [14]. The displays combine standard digital signage content (images and videos) with interactive applications through a state machine with two defined states: passive and active. In the passive state the displays show digital signage content arranged in a sequence and shown in a full-screen mode called UBI-Channel. In the active state the screen is divided into two areas, one always showing the UBI-channel and one offering a number of interactive applications to display users, called UBI-portal. This approach separates control concerns of display owners, giving them full control over UBI-channel, and display viewers, giving them full control over UBI-portal. Even though *UBI-hotspots* allow display users to take control of one part of the display, display users cannot gain control of the entire display even for short interactions. During the deployment, the authors have been mainly focusing and reporting on general problems of deploying, maintaining, and evaluating such a long-term multi-application display system and its use by the users "in the wild" [8]. The authors were the first to raise awareness of the value proposition in respect to display and location owners and its importance for success of such a long-term deployment [9].

e-Campus is a university wide installation of public displays also featuring a number of interactive applications such as interactive map, Flicker photo view, YouTube video view, art installations, and applications that show university-wide and location-specific content, among others [2]. The *e-Campus* system is based on "content channels" shared between content producers and display owners. Content providers are responsible for generating content in the form of images, videos, web pages, or live video streams and organizing then in content channels. Display owners can choose any number of content channels for presentation on their displays. However, the owners cannot preview the content within the chosen channels. They have to rely on the channel description and the reputation of the content providers. This shifts a certain amount of control over content selection and presentation from display owners to content producers. During the deployment, the authors have been focusing and reporting on a long-term acceptance and use of the system by display owners and content produces as the main stakeholders of their system [2].

SYSTEM OVERVIEW AND USE

Previous work has indicated three main types of stakeholders for interactive and networked public displays: display owners or display providers (i.e., people or organizations that physically own or operate public displays), content producers (i.e., people who produce and prepare content for the displays), and display viewers (i.e., people who look at or use the displayed content) [1]. In a first step, we identified key challenges and requirements of sharing control over displays between display owners and display users [4]. Starting from those requirements, we developed a web based display platform and a network of four interactive public displays (featuring a touch screen) with a number of interactive and concurrently runnning applicaitons [6]. The platform allows display owners to control the presentation and/or availability of applications, for example to specify time intervals when a specific application has to run, define display regions where applications can present their content, specify sequences of applications, or define priorities among other parameters. In addition, display owners can define how much time and space can be available to interactive applications and display viewers. In this way, display viewers can use interactive applications and their content through a touch interface.

We installed four networked displays in three buildings at the University of Lugano (USI). One display was placed in front of the university canteen, easily one of the most busy places on campus. The remaining three displays were placed in buildings featuring lecture halls and seminar rooms - two displays in a building used by the Faculty of Informatics, and one display in a building shared by students of the Faculty of Communication Sciences and the Faculty of Economics. Each display consists of a touch enabled LCD screen, a stand, a web camera, and a Mac Mini computer running Windows 7 and the Opera web browser. The developed web-based display platform runs in the web browsers in full screen mode and shows applications in one of four available "screen zones": full screen, side bar, main screen (i.e., area that is visible when side bar is shown), and a ticker tape running at the bottom of the screen. We deployed three social appli-

Figure 2. Examples of applications running on the displays. Top left: Twitter and Homepage applications. Top right: USI Career information. Bottom left: picture taking and galley applications. Bottom right: picture taking, USI Transportation, and application bar.

cation (a photo taking app that can share pictures on Facebook [12], a photo gallery, and a Twitter feed), 13 applications that show university-related content (USI Calendar, USI News and Events, USI Map, USI Sport, USI Showroom, USI Offices, USI Transportation, USI Housing, USI Bike Sharing, USI Info, USI Social, USI Career, and USI Promotions) and two utility applications for selecting other applications on the touch screens (an application bar that shows icons of available applications, and a larger "Homepage" that shows a list of application icons with their names). Figure 2 shows four examples of applications running in different display zones. We deployed the displays in February 2014 and they have been continuously running since then.

In order to understand trends of how the displays have been used at the university, we performed a quantitative analysis of touch interaction log data using descriptive statistics. As the deployment is still ongoing at the time of this writing, we report the use of the displays during the first 96 weeks of the deployment, i.e., from February 24, 2014 (week 1) until December 30, 2015 (week 96). This corresponds to four full academic semesters, including both summer and winter breaks when almost no students are present at the university. Figure 3 shows the number of application requests by display viewers per week of deployment and averaged across all four displays. On average, there were 46.98 application requests per week across all four displays. The majority of application requests came from the display in front of the university canteen (43.23%). The second and third most used displays are the displays in the Informatics building (22.70% and 18.00%). The display in the building shared by Economics and Communication students was used the least (16.07%).

If we look at the number of application requests over all weeks of the deployment, as shown in Figure 3, we can see that the use of the displays was highest at the beginning of the deployment, in the first eight weeks. Certainly, the novelty of those displays played a big role in these initial high usage values. Also, the displays were deployed at the beginning of the semester, when a large number of new students were coming to the university that could use the screens to search university related information. Also, on the first day of the deployment, the university announced the installation of the system through official communication channels. Fi-

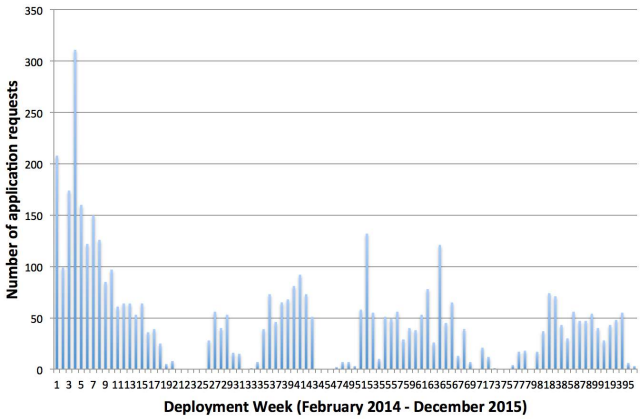

Figure 3. Average Number of Interactive Application Requests Using the Touch Interface Shown by the Week of the Deployment (Averaged Across the four Displays)

nally, week 5 saw two large student events, one for prospective students (Info Day) and one for current university students searching for career options (Career Forum). These events are held regularly, in particular in weeks 25, 52, and 81. Also, we looked at the distribution of application requests per each application. The most popular applications on the display were the photo taking application (25.47%) and the photo gallery (13.06%) followed by the University News and Events (8.71%) and Twitter (7.01%) applications.

NEEDS AND CONCERNS

The support of display owners was crucial for the preparation and deployment of the displays at our university. We started our engagement with the university administration almost two years prior the deployment. During this period, we first collected deployment requirements through short semi-structured interviews with several administrative units, in particular with the Student Advisory service (SAS) – which provides both study and career advice to students – and the Media and Communication service (MCS) – which handles both external and internal communications, i.e., both communicating university news to students and interacting with the press. We identified both SAS and MCS as potential entities for providing display content, and thus as entities that might help influence overall acceptance of the displays by the administration. Prior to the deployment, we also had to find appropriate locations for the displays, understand how to evaluate the acceptance of the displays by the student community, and assess the potential workload of providing content for the displays.

During the deployment, we captured the experience of both SAS and MCS staff through regular short meetings, designed to assess specific display and scheduling requirements and identify both existing and potential problems. After the first year of deployment, we also conducted six semi-structured and open-ended interviews with both SAS and MCS staff. Two participants were marketing and communication managers, one was a corporate communication manager, one was a web manager, and two were students doing an internship with the services. With these interviews, we tried to more formally assess and report on the needs and concerns of the administration with respect to deploying interactive displays at the university. Our results can be grouped into driving factors

(needs and motivations) and inhibiting factors (concerns). We will discuss each in turn in the subsections below.

Motivation and Needs

There were many different needs and motivations for having and deploying the screens at the university. SAS and MCS staff were mainly interested in using the displays as a way to explore a *new communication channel* for internal university communication, and to *enhance existing communication* with the student community. Also, the screens were seen as a resource to *promote university related information* – with a particular view towards a resource that would be "fun" to use – and as a way to increase the presence on *social media*.

A New Communication Channel

The university provides information to students through an official university website, a weekly email newsletter with news and events, and a quarterly printed university magazine. However, MCS staff thought that students were hard to reach through email with official institutional content. They saw an opportunity to use the screens as a local resource at the university to spread information to students:

"[P2] . . . we think there is a lack of internal communication, especially towards our students. We found that public displays are the perfect match for our needs, to fill that gap with the screens by feeding some institutional content towards students, stuff and professors. . . "

Internal Institutional Communication

Both SAS and MCS were interested in exploring the displays for spreading institutional content, internally communicating with students, informing people about the university, and building the university community:

"[P3] ... to test the displays as a possible channel for institutional communication and for community building ... we wanted to test content and to understand if we can use the displays as a valid channel for informing people about USI and strengthening the community ..."

"[P2] ... to communicate internally to students. We thought about it as information that is more locally and geographically useful for the community. The web site is for external communication, but for more internal communication we use it (display) as a way to promote information from the newsletter to the community."

Supporting University Events

An important motivation for using the displays was to support university related events, not only ahead of time in the form of advertising, but also during the event, e.g. as a dynamic sign, an interactive game, or an in-situ survey resource. For example, the photo taking application was seen as a way for participants to take and share pictures on social media platforms, reducing the need for a professional photographer:

"[P1] ... it's a way to showcase our university ... and I see it as a plus for every event. At the same time, the interactivity side is something that people are curious about and it gives an added value to the university events. It is fun and people can play with it ... it is something interesting than can be shared on social media, gives more visibility to the events outside the university and shows what is happening at the university on social media."

"[P1] They (the displays) cannot be missed from any event."

Over the course of the deployment, the initial motivation of having the displays expanded into the more general goal of showing that the university is a dynamic place where different events happen and where students can express themselves:

University Presence on Online Social Platforms

Both SAS and MCS have been using online social media to promote university related events and increase the presence of the university. They were interested in the opportunity to use the displays to explore and further enhance the use of social media within the university community:

"[P1] ... there were high expectations on how the screens will be able to enhance the use of social media within the university. The screens were a possibility to show that people use social media at USI and that USI is present online ... to have more people use social media at the university."

Deployment Concerns

The main concerns of deploying the displays were related to the lack of use of the display (i.e., lack of acceptance by student community), the misuse of the displays through inappropriate user-generated content, the "costs" of running the displays (i.e., the trade-off between invested resources and gained benefits for the university), and lastly concerns over the graphical design of the displays.

Design of the Displays

Before the deployment, MCS staff was concerned with the graphical design and branding of the displays (i.e., the content shown). Clearly, the content developed by us was done by PhD students, not by professional designers. We thus were asked to involve an official university designer in the development stage to ensure that the design of the displays and all of its institutional content matched the university's branding standards (e.g., fonts, colors, and image quality).

"[P2] ... because we were concerned about the design quality of the displays, and the quality of the content."

User-contributed Content

Before the deployment, most of our university administration contacts (i.e., SAS and MCS staff, but also the rector) were concerned about deploying interactive applications that show user-contributed content (such as the photo-taking application), which would potentially trigger complaints from the university community about inappropriate content:

"[P3] Concerns were that the students would be taking inappropriate pictures, and professors seeing these pictures would complain to us ... we had a little negative experience during one deployment when a student working for the communication services took an inappropriate picture."

"[P1] We were concerned about the content, in particular inappropriate content. It happened before and it was something that we expect, ... something that we were concerned especially in the case of high school students coming at the university, maybe with less maturity or experience and maybe with less knowledge and education. It is a digital native generation but at the same time they are naive, a certain inappropriate picture that could go to the web. I remember the

discussion and meeting when there was this fear of loosing control over content that can be displayed."

During the course of the deployment, the initial concerns were still present but they progressively became less important. Since there were no complaints from students and (maybe most importantly) from professors, the concerns were less pronounced. After an incident during a pre-deployment at an open day (referred to P3's comment above) we created a dedicated web page where MCS staff could see all pictures taken in real-time, with an easy removal functionality. Additionally, we created an in-situ tool that would allow MCS staff to use their electronic university badges to enable a quick "control" mode directly on the display, in case they saw a particularly offending image while at a display. While the existence of the page is still important, the page is currently visited less than once a week; the badge-based in-situ control module has so far never been activated.

"[P1] ... we are cautious that inappropriate content can appear. I think we are not worried about our students as it would mean that they would endanger themselves and their reputation in a known environment. We are more careful when we were having the displays for external events, specially with younger people."

"[P3] ... the concerns are are still there and it is important that this kind of concerns are present in order to monitor the displays. But I have seen only appropriate pictures and we got no complaints from professors. My concerns are less intense, almost faded away."

Preparing Institutional Content

Early on, MCS staff were very concerned about the time and resources that they would have to dedicate for preparing and updating content, and for managing the display in general (e.g., setting a display schedule). Without a clear idea of the impact that those screens would have at the university, MCS staff were reluctant to commit regular effort to the project.

"[P2] ... to know how and if the effort and the time we put to prepare content for the screens really pays the resources. We know that the screens are working but we don't know how well they were used to promote institutional content."

"[P3] ... it is important to know the cost of your initiative ... it is important to evaluate the cost because you have to have an overview of the project and to know if there is a benefit. I think it is balanced, there is a good balance in terms of cost and benefit for the displays."

SAS and MCS staff divide content for public displays into two categories: static and dynamic content. Content that is changing only rarely, such as the academic calendar (once per semester) or general information about university offices, is considered static. Content that requires a weekly update, such as News and Events, is considered dynamic. Static content is usually prepared for the official university website, while dynamic content is prepared for the weekly email newsletter. Before the deployment, SAS and MCS staff spent 4-5 hours preparing content in Italian and 4-5 hours translating it into English (for both the website and the weekly newsletter). With the screens, an additional 1-2 hours per week were needed to adapt this content for the displays. While adapting the content for the displays thus adds only 10-20% overhead, MCS staff repeatedly suggested to create a more integrated content management system that would automatically take already prepared content and adapt it for the displays. In addition, they strongly expressed the desire to preview the content before it appears on the screens, either on a dedicated web page or directly on the displays:

"[P2] ... to have more flexible content management system, like a content management system for dummies: to put content and then system takes all the care and makes it compatible with the displays."

Controlling Application Presentation

Prior to deployment, both SAS and MCS staff were concerned that user-controlled applications, such as the photo-taking and photo-gallery apps, would be taking more display time than university-related applications. Our administration thus required more strict controls over application presentation, and the possibility to lock the screen to one application (i.e., disable interactivity). MCS staff were particularly concerned about providing a precise time schedule for every day, in order to promote institutional content during fixed time slots. They specifically wanted to schedule the "News and Events" application before and after classes, without preemption (i.e., passers-by manually starting other applications).

However, during the second semester of the deployment, MCS staff increasingly started to give more time to social applications and to use combinations of two applications, i.e., one running in the sidebar and the other running in the remaining part of the screen. As our usage analysis showed, the most-used applications on the displays were social applications. This prompted MCS staff to consider the possibility to promote institutional content by showing it together with popular social apps simultaneously in different screen zones.

Acceptance of the Displays by the Student Community

At the beginning of the deployment, our SAS and MCS contacts were concerned about the acceptance of the displays, the offered applications, and the shown content by the student community. Demonstrating the initial acceptance of the displays turned out to be a hard requirement for continuing with our long-term deployment.

We thus spent a considerable amount of time during the first two semesters to collect, analyze, and present quantitative data about the display use (such as shown in Figure 3) and the popularity of applications and institutional content. This information was readily available through our logs on touch events, which told us when a particular application was started and how long explicit interactions with the apps lasted. In addition, we also performed several in-situ interviews (i.e., in front of the displays) in order to obtain direct feedback from students. After the first month of operations, we interviewed a total of 27 students from the different faculties present at the school, and across all years of studies (i.e., Bachelor, Master, and PhD students).

Key to convincing the university administration about the acceptance of the displays by the students was to demonstrate the students' attitude towards the practical information that

was available on the screens, such "News and Events", information about housing, transportation, sport, and the academic calendar. This was important information for the administration to understand that their efforts in providing such content was well received by the students. To demonstrate the acceptance, we reported the following quotes from the interviews:

"[S12] Exam Schedule is quite useful, also bus timetable. I am always late."

"[S13] At the bottom I can pick any application and after that I can get more information. With the News and Events I can see what's going to happen at the university."

"[S3] In general I think that most of the applications are very useful, especially when I first came to USI. I needed this kind of information but I couldn't find it. So for example, the USI Map for a newcomer is very convenient, or the USI Sports, or the USI Housing when you don't have a house, or USI Transportation. In general, I consider the displays very useful."

"[S6] I like the idea to have this information here. It is much more immediate and quicker to find information here on the display than on the the website."

"[S5] ... it shows that USI is organized. You can get what you want immediately. And it depicts all those extra things that not all schools have, e.g., sport activities."

Our university contacts were also interested in any constructive feedback regarding a potential for improving the displays. They saw it as an opportunity to not only improve the displays, but also to improve the official institutional communication with students. For example, we reported feedback about the design of the application icons that were used in the application selection bar and difficulties of choosing practical information represented by the icons:

"[S6] It is not really intuitive, especially the application bar. The visualization of applications in the homepage is clearer then in the application bar. We saw the small icons but we never understood what these were for. In addition, the meaning of some icons is not really evident."

"[S20] The graphical interface bothers me. When I open the small thing here these icons are not true represented, they do not represent the ideas I'm getting from them. For example, this is for me MySpace [icon with two people] and when I press it, I expect something social to get."

CONCLUSION

Display owners are important stakeholders in long-term display deployments as entities who physically own display resources and/or make decisions about displays' location, operation, and application and content presentation. The support of display owners is critical for the success of display deployments. In this paper, we have presented our own experience of a long-term deployment of an interactive multi-application display system in a university setting, and our engagement with the university administration during the deployment. We have briefly presented our system, reflected on its use over four academic semesters, and provided results from semi-structured interviews regarding the needs and concerns of the administration in deploying and supporting interactive applications and user-generated content.

Mainly, the university saw an opportunity to use the displays as a new communication channel that can complement their existing communication means towards the student community. They saw the displays as local resources for enhancing internal institutional communication and further building the university community. Also, promoting and supporting local university events and increasing the presence of the university on social media platforms were important motivations and needs of the administration. As we experienced in our work, it is beneficial to clearly set motivation and all design and development requirements before the deployment. The university administration saw an opportunity in installing the displays on campus and took our free offer to manage the deployment. However, without clear set of requirements, the administration was constantly changing and adding new features that drastically increased time and work we initially planned for the deployment.

In order to gain the support of the university administration for long-term deployment, we developed a set of interactive applications that show university related content such as USI News and Events and applications that can connect to online social media such as Facebook and Twitter. The administration wanted a variety of applications to offer to students with content that is always interesting. Before the deployment, it is important to understand who will provide content for different applications, even ones that will be rarely used. From our experience, underlying structure of the university administration and digital content already produced for other communication channels within the university provide an opportunity for content creation that can be used on public displays.

Also, before the deployment, the administration was mainly concerned about the graphical design of the displays, their workload of preparing institutional content, acceptance of the displays by the student community, and loosing control over user-contributed content and presentation timing of applications, in particular ones that show non-institutional content. Prior to the deployment, it was crucial to demonstrate that the university can precisely time the application presentation and make institutional content non-preemptive. Also, it was critical to provide mechanisms for handling potential misuse of the displays through inappropriate user-generated content. While the mechanisms may not be used on a regular basis, it is important for the administration to have an established process of actions when exceptional situations happen.

In the first months of the deployment it was important to show to the university how the displays have been used, the popularity of university related content, and the acceptance of the displays by the student community. From our experience, it is important to dedicate a significant amount of time to conduct user studies and provide quantitative and qualitative reports regarding the use and acceptance of deployed displays. While one cannot generalize from a single long-term deployment, we hope that our experience offers useful insights to developers of future interactive multi-application displays.

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